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Automatic Design of Optical Systems by Digital Computer

This computer program uses geometrical optical techniques and a least squares optimization method employing computing equipment embodied in the IBJOB monitor for the automatic design of optical systems. For any specified optical system, this automatic lens design program allows evaluation of changes in the following optical parameters:

- (1) All geometrical parameters of the axial conic surfaces.
- (2) Aspheric surfaces described by an even ordered polynomial.
- (3) All geometrical parameters of displaced or tilted conic optical surfaces.
- (4) Plane or curved image surfaces.
- (5) Indices of refraction of all elements of the optical system.
- (6) Reflective surfaces.
- (7) Stops utilizing circular or rectangular shapes.
- (8) Cylindrical elements.
- (9) Adjustment of off-axis objects or size of the angular field of view.

The ray tracing capabilities of this program are such that any number of rays (up to 100), in any desired pattern, may be directed and traced through an optical system to the plane upon which the image of the object is to be formed. When an optical system is to be ray-traced, the ray-trace program can be arranged to deal with the following characteristics:

- (1) Height of object from which rays are to be directed through the optical system. (Seven object heights are available.)
- (2) Distance of object to first lens surface.
- (3) Distance of image from last lens surface.
- (4) Distance of entrance pupil from first surface.
- (5) Pattern of rays to be traced.

- (6) Data for a curved image field.
- (7) Entrance pupil radius.
- (8) Number of planes on which spot size is desired.
 - (a) Spacing between the first image planes.
 - (b) Location of the first image plane.
- (9) Number of colors. (As many as six colors may be utilized.)
- (10) Rectangular or conic section stops.

By inserting the pertinent optical data from the above list into the program, the characteristics of an optical system may be determined. If the required input data are available, this determination may be made for existing optical systems or for proposed systems. The results may be used to determine whether an optical system meets stated requirements. The information printout generated from the above input data is as follows:

- (1) Color used.
- (2) Focal length of optical system.
- (3) Focal point of optical system.
- (4) Object height to specify field of view.
- (5) Exit pupil position.
- (6) f/number .
- (7) Back focus.
- (8) Number of rays traced throughout system.
- (9) Location of plane at which spot size is determined.
- (10) Average x and y positions of spot center.
- (11) RMS values of the x and y coordinates of the spot center.
- (12) Spot size, i.e., the rms radius of image spot pattern for each color and object height.

Notes:

1. This program is written in MAP language for an IBM 7090/94 computer alone or in direct couple to a 7040/44.

(continued overleaf)

2. Inquiries concerning this program may be directed to:

COSMIC
Computer Center
University of Georgia
Athens, Georgia 30601
Reference: B67-10632

Patent status:

No patent action is contemplated by NASA.

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